



U.S. Department of Energy
Energy Efficiency and Renewable Energy

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Federal Energy Management Program

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How to Buy an Energy-Efficient Air-Cooled Chiller

Information about energy-efficient air-cooled chillers in this section includes the following:

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Also provided is a portable document format version of *How to Buy an Energy-Efficient Air-Cooled Electric Chiller* (PDF 74 KB, 2 pp). [Download Acrobat Reader](#).

Efficiency Recommendation ^a		
Compressor Type and Capacity	Part Load Optimized Chillers	
	Recommended ^b IPLV ^c (kW/ton)	Best Available ^b IPLV ^c (kW/ton)
Scroll (30 - 60 tons)	0.86 or less	0.83
Reciprocating (30 - 150 tons)	0.90 or less	0.80
Screw (70 - 200 tons)	0.98 or less	0.83
Compressor Type and Capacity	Full Load Optimized Chillers	
	Recommended Full Load (kW/ton)	Best Available Full Load (kW/ton)
Scroll (30 - 60 tons)	1.23 or less	1.10
Reciprocating (30 - 150 tons)	1.23 or less	1.00
Screw (70 - 200 tons)	1.23 or less	0.94

^a Depending on the application, buyers should specify chiller efficiency using **either** full-load **or** integrated part-load values as shown (see text).

^b Values are based on standard rating conditions specified in ARI Standard 550/590-98. Only packaged chillers (i.e., none with

remote condensers) are covered.

^c Integrated part-load value (IPLV) is a weighted average of efficiency measurements at various part-load conditions, as described in ARI Standard 550/590-98. These weightings have changed substantially from the previous standard, ARI 590-92, lowering IPLV ratings by 10%-15% for the same equipment.

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Cost-Effectiveness Example 100-ton Screw Chiller			
Performance	Base Model^a	Recommended Level	Best Available
IPLV Efficiency (kW/ton)	1.25	0.98	0.83
Annual Energy Use	250,000 kWh	196,000 kWh	166,000 kWh
Annual Energy Cost	\$15,000	\$11,800	\$10,000
Lifetime Energy Cost^b	\$219,000	\$172,000	\$145,000
Lifetime Energy Cost Savings	—	\$47,000	\$74,000

^a The efficiency of the base model is just sufficient to meet the current ASHRAE Standard 90.1-99.

^b Lifetime energy cost is the sum of the discounted value of annual energy costs based on average usage and an assumed chiller life of 23 years.

Metric Conversions:

1 Ton = 12,000 Btu/h

1,000 Btu/h = 293 watts

°F = (1.8 * °C) + 32

1 Foot = 30.5 cm

Cost-Effectiveness Assumptions: Future electricity price trends and a discount rate of 3.4% are based on Federal guidelines (effective from April 2000 to March 2001). Annual energy use for the screw chiller example is based on 2,000 equivalent full-load hours per year for a 100 ton chiller. Assumed electricity price: \$0.06/kWh, the federal average electricity price (including demand charges) in the U.S. Since this average cost figure does not incorporate the disproportionately large portion of demand costs that chillers usually contribute, the cost savings figures may be conservative.

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Determine Your Own Project's Cost-Effectiveness

Try the [Energy Cost Calculator for Air-Cooled Electric Chillers](#) to compare the energy costs for your selection with FEMP-recommended and "Best Available" air-cooled chillers. You can model different scenarios by varying electricity cost, capacity,

efficiency, and hours of operation.

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How to Select Energy-Efficient Air-Cooled Chillers

Buyers should decide whether to emphasize full-load or part-load efficiency for their application. IPLV is preferred for more variable loads and variable ambient temperature and humidity, a situation common for air-cooled chiller applications. However, buyers may wish to put more emphasis on full-load performance in installations with staged chillers, or in locations where peak demand and demand charges are a primary concern. When selecting an air-cooled chiller, specify an energy consumption rate (in kW/ton) that meets the recommended level for that compressor type. The Air Conditioning and Refrigeration Institute (ARI) lists manufacturers' catalogues and software with ARI-certified ratings in its *Applied Directory* (see "[For More Information](#)").

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Buyer Tips

When deciding on a chilled water system, designers must choose either an air- or water-cooled chiller. Air-cooled systems eliminate the need for a cooling tower, reducing installation and maintenance costs. However, air-cooled chillers are substantially less efficient than water-cooled models (see "[How to Buy an Energy-Efficient Water-Cooled Electric Chiller](#)"). To compare air- and water-cooled options, a detailed life-cycle cost analysis can be performed using FEMP's "[Building Life-Cycle Cost](#)" (BLCC) software (see "[For More Information](#)"). Maintenance costs for air-cooled chillers vary by compressor type. Screw and scroll compressors cost more initially, but can operate longer before overhauling.

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Sizing

When selecting a chiller, careful attention to appropriate sizing is critical. An oversized chiller not only costs more to purchase but also wastes energy due to poor low-load performance and excessive cycling. Use the referenced [ASHRAE calculation procedure](#) to determine the cooling load. It is often cost-effective to combine a chiller replacement with other measures that reduce cooling load, permitting specification of smaller capacity chillers (see the [Cool Sense Web site](#)).

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Environmental Tips

Refrigerants with ozone-destroying chlorofluorocarbons (CFCs) were common in older chillers but are not used today. The 1992 Montreal Protocol banned the production of CFCs in the U.S. beginning in 1996. Most air-cooled chillers sold today use hydrochlorofluorocarbon (HCFC) refrigerants, which have a much lower ozone-depleting effect. There are many energy-efficient chillers on the market that use HFC refrigerants, with no ozone-

depleting effect. When retiring a chiller that contains CFCs or HCFCs, the Clean Air Act requires that the refrigerant be recovered on-site by a certified technician. (For information, call (800) 296-1996.)


Noise pollution can be a substantial issue with air-cooled chillers. Rotary screw and scroll compressor models are generally considerably quieter than reciprocating models.

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For More Information

- [American Council for an Energy-Efficient Economy \(ACEEE\)](#) publishes the *Guide to Energy-Efficient Commercial Equipment*, which includes a chapter on HVAC systems, as well as a listing of chiller models that meet this Recommendation.
Phone: (202) 429-0063
- [ASHRAE](#) publishes the *Cooling and Heating Load Calculation Manual*.
Phone: (800) 527-4723.
- [Air-Conditioning & Refrigeration Institute \(ARI\)](#) publishes the *Applied Directory*, which lists manufacturers' catalogues and software with ARI-certified capacity and efficiency ratings. This information is also available through ARI's on-line directory, [Prime Net](#).
Phone: (703) 524-8800
- [E SOURCE](#) publishes the *Electric Chillers Buyer's Guide*.
Phone: (303) 440-8500
- Lawrence Berkeley National Laboratory's ["Cool \\$ense" Web site](#) has a variety of resources to help in combining building retrofits with chiller replacements.
- Lawrence Berkeley National Laboratory provided supporting analysis for this recommendation.
Phone: (202) 646-7950

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Content Last Updated: 12/03/2003